

Performance Standards for Dwellings Advancements and Opportunities Nationally and Internationally

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Introduction

The historic development and use of the performance approach for specifying and evaluating buildings, their materials, components, subsystems and systems, has led us to the threshold of a new era which holds great promise. Over the years the performance approach for procuring and regulating building design and construction has been touted, studied, debated, and used in limited settings, but it has not been advanced adequately to be more fully embraced by the industry as a whole. Today's shrinking world with its expanding global economy and ever increasing rate of advancements in technology presents a need and opportunity for greater application of the performance approach to the design, procurement, construction and regulation of buildings. This reality is being recognized in the U.S. and abroad and is beginning to be addressed by the building owners/developers, design professionals, materials and product manufacturers, builders, standards development organizations, the model code organizations, and regulators. One key thrust has been in the development of performance standards for dwellings.

In November of 1995 Mr. James G. Gross of the Building and Fire Research Laboratory (BFRL) of the National Institute of Standards and Technology (NIST) presented a paper to the NCSBCS/NIST/HUD Joint Technical & Research Conference describing activities underway and planned for the development of performance standards for dwellings¹. Much has happened since then and significant activities are on-going and planned for the future. This paper will describe these activities and describe opportunities that exist for advancement through research and participation in the standards development process.

Background

One definition of the performance concept is as follows:

A framework for specifying and evaluating qualities of building products and systems to meet user needs without limiting ways and means¹.

In order for this approach to be used for the programing, procurement, and evaluation of buildings, a structure for writing performance statements is necessary and such a structure has evolved. The terms used to describe this structure often vary (adding to the confusion that surrounds the practical

application of the performance approach), but the components are generally the same. At the National Institute of Standards and Technology (NIST) this framework is referred to as the *RCEC format* and includes the following:

Requirement - a qualitative statement giving the user need or expectation for the item being addressed. It is a general statement of what the product or assembly is intended to do.¹

Criteria - quantitative statements giving the level of performance required to meet the user needs or expectations for the item being addressed.¹

Evaluation - sets forth the methods of tests and/or other information upon which a judgment of compliance with the criterion will be based. It states the standards, inspection methods, analysis, review procedures, historical documentation, test methods, in-use performance, engineering analyses, and models which may be used in evaluating whether or not the criterion has been satisfied.¹

Commentary - provides background for the reader and presents the rationale behind the selection of specific data presented in the requirement, criterion, or evaluation. The commentary is provided for informational purposes.¹

Applying the performance concept to building procurement and regulation is not a new idea. There are both historic and modern examples that can be cited. In my professional life there are a number of examples including:

- The 1960s school building programs in the U.S. and Canada, wherein large numbers of facilities were designed, purchased and built using the performance approach.
- The U.S. Department of Housing and Urban Development's *Operation Breakthrough* of the early 1970s, which employed the performance approach to procure housing of various types from industrialized systems manufacturers which were erected on sites throughout the U.S.
- European and Middle Eastern housing procurement of the late 1970s.

Over this period of more than thirty years the performance approach has been the subject of many scholarly papers; it has been accepted philosophically and intellectually and has been the focus of three major international conferences², yet the concept has not been used broadly. This is true in spite of all of its professed merits (e.g., removes barriers to innovation, can lead to better performing buildings, can reduce costs). There may be a number of reasons as to why there has been a lack of widespread application:

- Lack of acceptance of a common set of terms and definitions including the performance concept itself.

- Lack of understanding that the performance approach and the prescriptive approach are not at odds with each other, but rather that the two ideas are meant to work together. In order for buildings to be designed and built (i.e., procured and regulated), all performance statements (RCEC) must eventually be converted into prescriptive solutions.
- Lack of knowledge regarding user needs or requirements; service-life prediction (i.e., performance over time) of building materials, products, components, systems and whole buildings; economic benefits (e.g., productivity in the workplace, health and welfare of occupants) that may accrue as a result of innovation.
- Lack of standards to facilitate communication and application. These include performance requirements for a wide variety of subsystems and systems and enhanced evaluation methods (prescriptive tests) for measuring acceptance against explicit criteria.
- Lack of education in the practical application of the performance approach.

Change is on the Horizon

Recent events of historic magnitude have occurred around the world and in the U.S. which have set the stage for a major change regarding the need for and potential application of the performance approach for building specification and evaluation. Events such as the creation of the European Union and its evolution toward a single economy, the end of the Cold War leading to the further opening of markets in eastern Europe, the formation of regional trade organizations (e.g., Asia-Pacific Economic Cooperation - APEC³), the execution of free trade agreements (e.g., North American Free Trade Agreement - NAFTA and the General Agreement on Tariffs and Trade - GATT⁴), and the establishment of the World Trade Organization (WTO)⁵ have all contributed to the creation of an environment for international trade unparalleled in modern times. This environment is not only conducive to the application of the performance approach, in many ways it makes it imperative. The performance approach allows for the specification and evaluation of materials, products, components, subsystems and systems produced or manufactured in one location to compete openly and fairly with those coming from elsewhere. This need and clear benefit is being recognized by leaders in the building industries of nations around the world.

In the United States significant actions have been initiated that will advance the development and application of the performance approach.

- The International Code Council (ICC), an organization created by the three model code organizations⁶, is developing a single set of model building codes to be available for adoption nationwide before the year 2000. Included within this effort is the creation of a performance based code.

- The National Association of Home Builders Research Center, in support of the Subcommittee on Construction and Building of the National Science and Technology Council's Committee on Civilian Industrial Technology, issued *Action Plans for Achieving High-Priority National Construction Goals in the Residential Sector*, March 1997. This report identifies seven strategic approaches aimed at two underlying goals -- reducing production cost and improving product durability. Within this framework specific action items call for improved understanding of building performance and fostering the development and commercialization of innovative products and systems.
- As a result of the efforts of a broad-based building industry and government Partnership for Building Innovation, facilitated by the Civil Engineering Research Foundation (CERF), the National Evaluation Service (NES)⁷ has recently founded the Building Innovation Center (NES-BIC). The center will provide independent technical evaluation services for building technologies of all types and can be used to gain credible information on the performance of new and innovative materials, products, components, and systems.

Performance Standards for Dwellings

There are a number of specific activities underway that will provide significant opportunities for U.S. participants in the residential construction sector to contribute to advancing the development and application of the performance approach both at home and abroad.

ASTM E6.66 - Subcommittee on Performance Standards for Dwellings

The American Society for Testing and Materials (ASTM) Committee E-6 on Performance of Buildings established E6.66, a subcommittee on Performance Standards for Dwellings in October of 1995. The subcommittee has met three times since that date and has grown to a present membership of eighty-seven (87) individuals. The subcommittee has agreed to pursue the development of a set of performance standard guides for the specification and evaluation of one- and two-family dwellings. The guides would be used by procurers of housing, designers, housing systems integrators, and subsystems producers. While it is intended that the performance of a traditionally designed and constructed dwelling unit would fit within the guide parameters, the principal users of these standard guides would be innovators -- those whose materials and/or methods are new and not readily covered by prescriptive standards and traditional practices. These standard guides are not to be written in mandatory language and are not intended to be adopted as reference standards in regulatory documents.

The guides will be developed using the RCEC format for performance statements. Each guide will address one of several attributes and present the performance statements in accordance with an agreed upon hierarchy of building subsystems. The goal is to have the set work together to describe

the “whole” dwelling unit and present the guide material in a format that allows cross-cutting by building subsystem or other desired interfaces. Ultimately the material contained in the standard guides may be most useful when presented in a relational database.

Presently sixteen attributes have been defined as necessary to fully describe the “whole” dwelling unit. These include the following:

- (a) Structural Safety
- (b) Fire Safety
- (c) Accident Safety
- (d) Health and Hygiene
- (e) Indoor Environment
- (f) Visual
- (g) Acoustics
- (h) Durability
- (i) Accessibility
- (j) Security
- (k) Economic Performance
- (l) Functionality
- (m) Aesthetics
- (n) Adaptability
- (o) Maintainability
- (p) Sustainability

Of this group initial draft guides have been presented to the subcommittee covering Structural Safety, Fire Safety, Durability, Accessibility, and Functionality. Drafts are presently being initiated for Visual, Maintainability, and Adaptability. All of these initial efforts are expected to be significantly enhanced through the subcommittee efforts.

The attribute based guides will be written against a single building subsystem hierarchy such that there will be uniformity from one standard guide to the next. The present building subsystem hierarchy includes the following:

- (1) Spaces
- (2) Structure
- (3) Exterior Enclosure
- (4) Interior Space Division
- (5) Plumbing
- (6) Electrical
- (7) Lighting
- (8) HVAC
- (9) Fuel
- (10) Communication

It is anticipated that this hierarchy will be the subject of significant modification and enhancement by the subcommittee in the immediate future.

The subcommittee has created Task Groups to address the initial attribute guides under development. It is anticipated that there will be a Task Group for each of the guides. Working within these Task Groups will afford all participants the opportunity to help mold the guides.

It is anticipated that these efforts will generate initial pre-standard guides ready for subcommittee and full committee balloting in 1998. While the time required to complete the process may be difficult to predict, it is important that the effort not be delayed. A target date of 2000 is an attainable goal. The next meeting of the Task Groups and the subcommittee is set for October 13, 1997 in San Diego, CA.

ISO/TC 59/SC 3/WG 10 - Performance Criteria for Single Family Attached and Detached Dwellings

The International Organization for Standardization's⁸ Technical Committee 59 (Building Construction) includes in its scope the standardization of general rules for performance requirements for buildings and building elements. Subcommittee 3 tasked Working Group 10 to prepare a detailed strategy for the development of performance-based housing standards by June of 1997. This Working Group includes representatives from Australia (Convener and Secretary), U.S., South Africa, Norway, Japan, UK, Korea, and New Zealand. Overall the WG participants are enthusiastic and the scope of activities has led to the recommendation that the WG activities be elevated to a subcommittee (SC 14) for implementation. The leadership of this WG has come from Australia, U.S., and Japan.

The ISO approach is very similar to that being taken by ASTM. The WG is looking at developing a suite of attribute-based international standards specifying the performance of houses, systems and components in terms of user needs (requirements), criteria, evaluation methods, and commentary. In addition to the individual stand-alone documents the suite would include a general principals document.

The stated purpose of this effort is to --

...facilitate international trade, innovative design and construction, and insurance of these systems and components. These standards will be suitable for adoption by national standards organisations in both developed and developing countries and used by purchasers of housing, manufacturers, designers, builders, regulators, housing policy makers and technical assessment organisations⁹.

Initial draft documents have been presented on first priority issues including structural adequacy (Australia), fire safety (U.S.), durability (U.S.), and functionality (U.S.). The U.S. also prepared and delivered a document titled, *Guide Document for the Preparation of Performance Standards*, June 1997, to assist the WG in more uniformly preparing and discussing its work. Second priority

documents include accident safety, health and hygiene, indoor atmosphere, accessibility, and economics. The balance of documents would comprise the third level priority. The U.S. has accepted the lead responsibility for documents on indoor atmosphere, economic performance and aesthetics. Working groups are to be established for the priority one efforts and opportunities exist for the U.S. to both lead and participate in the development of these documents.

The schedule developed by the WG calls for first Working Drafts for the priority one documents to be complete by the end of 1997, committee Drafts for these documents in June of 1999, and Final International Standards for these one year later. The next meeting is scheduled for Sydney, Australia in January 1998.

NIST/BFRL's Performance Standards System for Housing (PSSH)

The Building and Fire Research Laboratory (BFRL) of the U.S. Department of Commerce's National Institute of Standards and Technology (NIST) has established a program to support the advancement of the performance approach for housing. This program consists of three principal areas of activity:

- Development of performance standards for housing both nationally and internationally.
- Advancement of capabilities in evaluating and measuring performance of housing and its components and subsystems.
- Partnering with U.S. housing industry participants in the application of the performance approach with the objective of increasing opportunities for innovation and enhancing competitiveness.

The BFRL's principal purpose is to enhance the competitiveness of U.S. industry and public safety through performance prediction and measurement technologies and technical advances that improve the life-cycle quality and cost effectiveness of constructed facilities. BFRL's efforts are closely coordinated with industry, professional and trade organizations, academe, and other agencies of government. In addition to NIST, the PSSH program is expected to be supported by the U.S. Department of Housing and Urban Development and the U.S. Department of Energy.

The PSSH is actively supporting the efforts of ASTM E6.66 and ISO/TC 59 described above. The BFRL technical staff have facilitated activities in these two organizations and will continue to provide technical support. The level and nature of involvement of BFRL technical staff is expected to be modified as the members of the task groups, working groups, and subcommittees become more active in the development of the guides and the creation of consensus documents.

One of the most significant benefits of the standards development process will be the continued identification of important opportunities to advance the ability to measure, evaluate, and predict performance against explicit criteria. This means improving the ability to do such measuring,

evaluating, and predicting in a manner that is not only acceptably reliable but cost effective. This capability is key to the successful application of the performance approach. The PSSH includes a research component aimed at addressing such issues and looks forward to input from the standards development process to help define and focus such efforts.

The research component of PSSH is also drawing on input expressed by industry through the NAHB Research Center's report, *Action Plans for Achieving High-Priority National Construction Goals in the Residential Sector*, March 1997, and on-going activities. Specific research programs are being planned regarding the following:

- Standardized Methodology for Predicting the Service Life of Non-structural Residential Construction Materials.
- Analytical Performance of Single Family Housing.
- Development of Knowledge-based Risk-consistent Methodology for Estimation of Wind Loads on Buildings.
- Develop Standard Economic Methods and Software Applicable to Performance Standards Trade-offs.
- Validation of Predictive Methods Intended for Use in Indoor Atmosphere Evaluations within the Framework of Residential Performance Standards.
- Feasibility Study for Improvements in Residential Fire Safety Performance.

All of this work will be done with industry involvement to varying degrees. General coordination and cooperation with the NAHB Research Center has been initiated and is anticipated to continue to assure that activities at BFRL and the Research Center are supportive. BFRL has on-going relationships with industry and with industry consortia through Cooperative Research and Development Agreements (CRADA). Added industry participation, either directly or through some advisory capacity, is important to achieve the ultimate objectives of application.

BFRL has recognized this need and is openly seeking industry input to the program as it evolves and is implemented. In addition to BFRL's own strong ties to industry, the laboratory has called upon HomeBase, a residential industry technical information exchange program, to assist PSSH in this regard. HomeBase, run by the NAHB Research Center, will provide liaison services to help identify companies and individuals who are considered innovators and who could benefit most from the advances being sought. Such industry representatives may chose to work in some type of pilot mode to apply the evaluation and measurement tools and standards that result from this program.

In addition, the BFRL anticipates working through the NES-BIC as a "window to the industry". The NES-BIC is in a start-up mode and will actively be looking to identify candidate technologies,

products, systems, and/or subsystems to serve as pilots for its evaluation process. These candidates also may serve to provide valuable insight into the development of enhanced evaluation methods and related performance standards.

The PSSH program recognizes that the three components (standards development, supporting research, and industry application) must proceed in parallel, linked to each other such that progress is achieved incrementally. As advances are made in one area, feedback will serve to enlighten, improve and accelerate the accomplishments in the others.

Other Opportunities

ICC International Building Code Performance Committee

In parallel to the development of the International Building Code (IBC), the ICC, through its Performance Committee, is working on the creation of the ICC Performance Code. The committee has published the intent, scope and performance structure document being used to develop the performance provisions. Draft provisions have been written for parts of the code and a "Guidelines for Use" document is also in progress. A review of the International Building Code related to the committee's performance approach is scheduled for the 1998/1999 time frame.

It can be assumed that as the ICC completes work on its initial family of codes, the work of the performance committee will begin to get even more attention. The performance committee and its work holds great promise for the ICC and the U.S. interests as participants in the arena of international trade and standards.

A Chance to Contribute

As stated at the outset, we are at a threshold of opportunity to open more widely the doors to innovation and allow for greater competition domestically and abroad. The stage is set for significant advances in the development and application of the performance approach within the building industry. It is a time when the traditionally interested parties (academia, research institutions, government) need to be joined by, and in many ways take a back seat to, the leaders of industry. Strong industry involvement is necessary to assure that this opportunity proceeds toward practical tools for practical applications.

Much of the impetus for this work in the international community comes from foreign industry. The U.S. is in a position to continue to participate as a leader, but it is imperative that U.S. industry step forward and actively participate, both domestically and internationally, if we are to maintain this leadership role. The consequences of not leading may prove to be too costly to accept; other countries will set the standards.

Endnotes

1. James G. Gross, *Performance Standards for Dwellings - To Stimulate Innovation and Improve Competitiveness*, (Technical Papers from the NCSBCS/NIST/HUD Joint Technical & Research Conference held in Albuquerque, New Mexico November 2-3, 1995).
2. RILEM-ASTM-CIB first International Symposium on the Performance Concept in Buildings, Philadelphia, PA, May 1972.
RILEM-ASTM-CIB second International Symposium on the Performance Concept in Buildings, Lisbon, Portugal, spring 1982.
CIB-ASTM-ISO-RILEM 3rd International Symposium on Applications of the

Performance Concept in Buildings, Tel-Aviv, Israel, December 1996.

3. Asia-Pacific Economic Cooperation (APEC) was formed in 1989 in response to the growing interdependence among Asia-Pacific economies. Begun as an informal dialogue group with limited participation, APEC has since become the primary regional vehicle for promoting open trade and practical economic cooperation. Its goal is to advance Asia-Pacific economic dynamism and sense of community. Today, APEC includes 18 member economies.
4. The General Agreement on Tariffs and Trade (GATT) was two things: (1) an international agreement, i.e. a document setting out the rules for conducting international trade, and (2) an international organization created later to support the agreement. While GATT no longer exists as an international organization, the GATT agreement lives on. The old text is now called "GATT 1947". The updated version is called "GATT 1994".
5. The World Trade Organization's (WTO) creation in 1995 marked the biggest reform of international trade since 1948. The WTO is the only international body dealing with the rules of trade between nations. At its heart are the WTO agreements, the legal ground-rules for international commerce and for trade policy. The agreements have three main objectives: to help trade flow as freely as possible, to achieve further liberalization gradually through negotiation, and to set up an impartial means of settling disputes.
6. The ICC was founded by the Building Officials and Code Administrators International, the International Conference of Building Officials, and the Southern Building Code Congress International.
7. The National Evaluation Service, Inc. (NES) is an independent, not-for-profit organization that conducts a voluntary program of evaluation for both traditional and innovative building materials, products and systems. The purpose of NES is to develop technical reports containing descriptions of a building construction material or product, together with a list of conditions necessary for compliance with each of the model codes, as promulgated by Building Officials and Code Administrators International, Inc. (BOCA), International Conference of Building Officials (ICBO), and Southern Building Code Congress International, Inc. (SBCCI). National Evaluation Service reports are issued to provide information to governmental units or agencies that utilize the code upon which the report is based.
8. The International Organization for Standardization (ISO) is a worldwide federation of national standards bodies from some 100 countries, one from each country. ISO is a non-governmental organization established in 1947. The mission of ISO is to promote the development of standardization and related activities in the world with a view to facilitating the international exchange of goods and services, and to developing cooperation in the spheres of intellectual, scientific, technological and economic activity. ISO's work results in international agreements which are published as International

Standards.

9. ISO/TC 59/SC 3/WG 10, Performance Criteria for Single Family Attached and Detached Dwellings, *Draft Strategy And Work Program*, June 1997